Title: Pattern Olympics

Brief Overview:

In this unit, students will be able to find the core pattern using several strategies and determine the rule. They also will analyze and recognize algebraic properties, and present and develop a graph using statistical information from the Olympics.

NCTM 2000 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

- **Content Standards**

Number and Operations

- *Understand numbers, ways of representing numbers, relationships among numbers, and number systems.*
- *Understand meanings of operations and how they relate to one another.*
- *Compute fluently and make reasonable estimates.*

Algebra

- *Understand patterns, relations, and functions.*
- *Represent and analyze mathematical situations and structures using algebraic symbols.*
- *Use mathematical models to represent and understand quantitative relationships.*
- *Analyze change in various contexts.*

Data Analysis and Probability

- *Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.*
- *Select and use appropriate statistical methods to analyze data.*
- *Develop and evaluate inferences and predictions that are based on data.*
- *Understand and apply basic concepts of probability.*

- **Process Standards**

Problem Solving

- *Build new mathematical knowledge through problem solving.*
- *Solve problems that arise in mathematics and in other contexts.*
- *Apply and adapt a variety of appropriate strategies to solve problems.*
- *Monitor and reflect on the process of mathematical problem solving.*

Reasoning and Proof

- *Recognize reasoning and proof as fundamental aspects of mathematics.*
- *Make and investigate mathematical conjectures.*
- *Develop and evaluate mathematical arguments and proofs.*
- *Select and use various types of reasoning and methods of proof.*

Communication

- *Organize and consolidate their mathematical thinking through communication.*
- *Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.*
- *Analyze and evaluate the mathematical thinking and strategies of others.*
- *Use the language of mathematics to express mathematical ideas precisely.*

Connections

- *Recognize and use connections among mathematical ideas.*
- *Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.*
- *Recognize and apply mathematics in contexts outside of mathematics.*

Representation

- *Create and use representations to organize, record, and communicate mathematical ideas.*
- *Select, apply, and translate among mathematical representations to solve problems.*
- *Use representations to model and interpret physical, social, and mathematical phenomena.*

Grade/Level:

Grade 5

Duration/Length:

Four to five lessons, 40 - 50 minutes each

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Constructing a table
- Finding averages
- Constructing graphs
- Recognizing patterns

Student Outcomes:

Students will:

- work cooperatively in groups.
- analyze a given pattern using several strategies.
- construct bar graphs using given data.
- have an understanding of the commutative properties of addition and multiplication.
- develop strategies to algebraically solve for a missing variable.

Materials/Resources/Printed Materials:

- Toothpicks
- Looseleaf paper
- Student calculators
- Empty paper towel roll
- Two paper towels
- Unifix cubes (at least three colors)
- Student Resource Sheets #1-7
- Transparencies of Teacher Resource Sheets #1-9
- Overhead projector
- Overhead calculator

Development/Procedures:

Day 1: Opening Ceremonies

Motivation: Have students form cooperative groups and brainstorm what they know about the Olympics. Make a list on the board or an overhead. Discuss briefly the history of the ancient and modern Olympics, with emphasis on the torch-bearing and lighting ceremony. (Teacher Resource #1)

Distribute the torch-bearing assignment (Student Resource #1) to the class. Have the students read the assignment silently. Ask one student to stand and read it aloud. Have the students name strategies for solving this problem. Pose guiding questions, if necessary, to lead the students to pattern solving strategies. Have the students use their strategies to find the pattern and develop the rule to complete Student Resource #1. See answers on Teacher Resource 2**.**

Model on the board or an overhead how to write the process used to find the pattern and develop the rule.

Make a table.

Torchbearer	Meters
1	15
2	25
3	35
4	45

Make a model.

Make a drawing.

Develop a rule. T x 10 +5 = M, where T is the number of torchbearers, and M is the number of meters.

Call attention to the writing rubric, Teacher Resource #3. Teacher will present an explanation of the problem solving scheme and rule developed. Have the students score the teacher's math writing example. Ask questions about each criteria on the rubric.

Day 2: Stadium Design

Review strategies to find patterns. Review the math writing rubric. Pass out Student Resource #2 (Stadium Design). Have the students read the directions silently. Ask one student to read the directions aloud. Ask the class what they are being told to do, and what is the nonessential information. Pass out a box of toothpicks to each table. Have the students make the models described in Student Resource #2. Ask the students to work independently to finish.

Model Strategies:

Make a table:

Doors	Toothpicks
1	5
2	9
3	13
4	17

Make a model.

Make a drawing.

Develop a rule. D x 4 + 1 = T, where D is the number of doors, and T is the number of toothpicks.

Have the students pair-share their writing. Ask the students to score their partners' papers with a 3, 2, or 1 using the Math Rubric (Teacher Resource #3) and explain the score to their partner.

Day 3:

Review the math pattern strategies and the math writing rubric. Refer to Teacher Resource #5. Perform the demonstration. Pose the questions to students. Discuss strategies used to determine cube colors. Distribute Student Resource #3. Have the students read it silently. After all are finished, ask one student to read it aloud. Ask the class to tell what they are to do in their own words. Allow time for the students to color the banners and answer the questions. Select students to answer the questions. Discuss their strategies to solve the banners colors.

Day 4:

Review the previous day's lesson on strategies that the students used to identify the core pattern and the rule developed to identify specific terms in the pattern (for example, the 20th term). Review and note that the rule involves an algebraic equation.

Place a rule that was used during Day 2 (the lesson having to do with doorways) on the board/overhead.
D x 4 + 1 = N
20 x 4 + 1 = 81
Discuss the commutative property of addition and multiplication.

On the board/overhead, write the judges' scores given to a gymnast at the Olympics in floor exercises (8.2, 7.8, 9.0, 9.0, 8.6, 8.9). Ask your students if it would make a difference in the average if the scores were added in a different order. Ask the students what they would call the property that allows one to do this.

Distribute Student Resource #4 and have the students read the directions silently. Discuss the importance of each score in determining the average score. Model working an example. Have the students work silently and individually on the first problem while you walk around the room observing progress. Have the students discuss, in their groups, how they worked through the first problem. Ask for a group to share their answer(s). Allow the students time to complete their problems. Check the work in class.

Day 5:

Review the unit's vocabulary in patterns, as well as commutative properties of both addition and multiplication. Have a student write a problem on the board illustrating the two properties.

Assign the students to cooperative groups of four. Ask the students how often the Summer Olympics occur. Distribute Student Resource #5. Have the students read the directions silently. Have one student read the directions out loud. Have the students complete the Olympic dates and discuss the rule.

Explain how Olympic information may be displayed on graphs. Discuss parts of a bar graph, the importance of exact spacing of intervals and numbers. Distribute Student Resource #6. Have the students read the directions silently. Have one student in each group read the directions to their respective group. Have the students use the data to make a bar graph. Have students score the graph in their cooperative groups using the Bar Graph Grading Criteria (Student Resource #7).

Performance Assessment:

The assessment for this unit will be on-going. The students will be assessed on class participation, working in cooperative groups, completion of daily practice sheets, math writing following a modeled math writing rubric lesson, displaying the ability to follow guidelines in pattern core formation as observed by the teacher, and making a bar graph according to specified criteria.

Extension/Follow Up:

During this unit an activity table will be provided where students may develop patterns using unifix cubes following guidelines specified on cards. The student will identify the rule of the pattern. Books will be provided to illustrate patterns in nature and fractals.

Authors:

Anna Brophy
Diamond Elementary
Montgomery County, MD

Bob Glass
The Newport School (Private)
Montgomery County, MD

History of the Olympic Games

The first recorded Olympic Games were held in Greece in 776 B.C. They were held every four years for over a thousand years. The first event was a 200 meter sprint. Later, chariot racing, wrestling, boxing, horse-riding, and other foot races were added. The Roman Emperor, Ineodosius, banned the Games in 393 A.D.

The modern Olympics began in Athens, Greece over fifteen hundred years ago. In April of 1896, thirteen countries participated in the first Olympics organized by Baron Pierre de Coubertin. The first Olympics was limited to only male athletes, but the second Olympics in 1900 had nineteen women competing.

The Olympics are opened by the torch lighting ceremony. The Olympic flame is taken by a torch relay from the ancient site of Olympia to the modern site of the Olympic competition. The flame is transferred from torch to torch.

Opening Ceremonies

Your class has been asked to carry the torch for our first school Olympics. The first torch-bearing class representative will carry the torch for a distance of 15 meters. All following bearers will carry the torch for 10 meters each.

How far has the torch been carried after the first 10 torch-bearers? 105meters

How far has the torch been carried after the first 22 torch-bearers? 225 meters

Math Writing Rubric

3	Student will clearly answer the question using supporting evidence and math terminology in a clear and concise manner.
2	Student will answer the question with some supporting evidence.
1	Student does not cite supporting evidence or is unable to communicate their understanding.

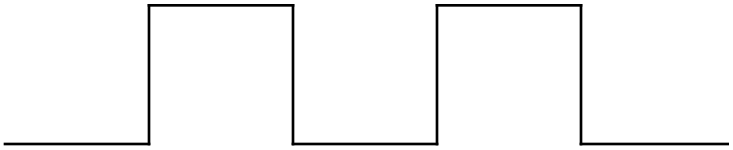
Teacher Resource #4

Architect's Design

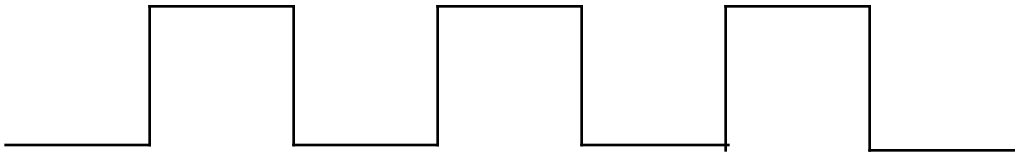
Directions: On the opening day of the Olympics, the athletes will need to enter the stadium from their dressing areas below the stadium arena. The architect's job is to design a stadium with 50 tunnels leading to the dressing rooms. Each tunnel will need a separate doorway. A toothpick will represent a 2.5 meter framing timber.

Now make a doorway using five toothpicks as shown below.

Now make two doorways using nine toothpicks as shown below.



Now make three doorways using 13 toothpicks.



How many toothpicks would you need for 20 doorways? ____81 Toothpicks

How many toothpicks would you need for 50 doorways? ____201 Toothpicks

On a separate sheet of paper, write the process describing how you found the pattern and developed the rule.

Banner's Unit

Teacher's Guide: To be used before Banners worksheet to illustrate strategies to solve pattern and develop rule.

Materials: Paper towel roll
12 Unifix Cubes in three different colors
Two paper towels

Directions: Place the unifix cubes in a core sequence. For example, W, W, R, W, and B.
Repeat the sequence until you have used 12 cubes.
Place the connected cubes in the towel roll and stuff a paper towel in each end.
Show the roll to the class and ask a student to choose an end to open.
Pull the Unifix cube strip slowly from the tube, one color cube at a time.

Questions: Ask the students to identify the core pattern.
Have them identify the color of the 13th cube.
Have them identify the color of the 25th cube.
Ask them to identify strategies they used to determine the cube colors.

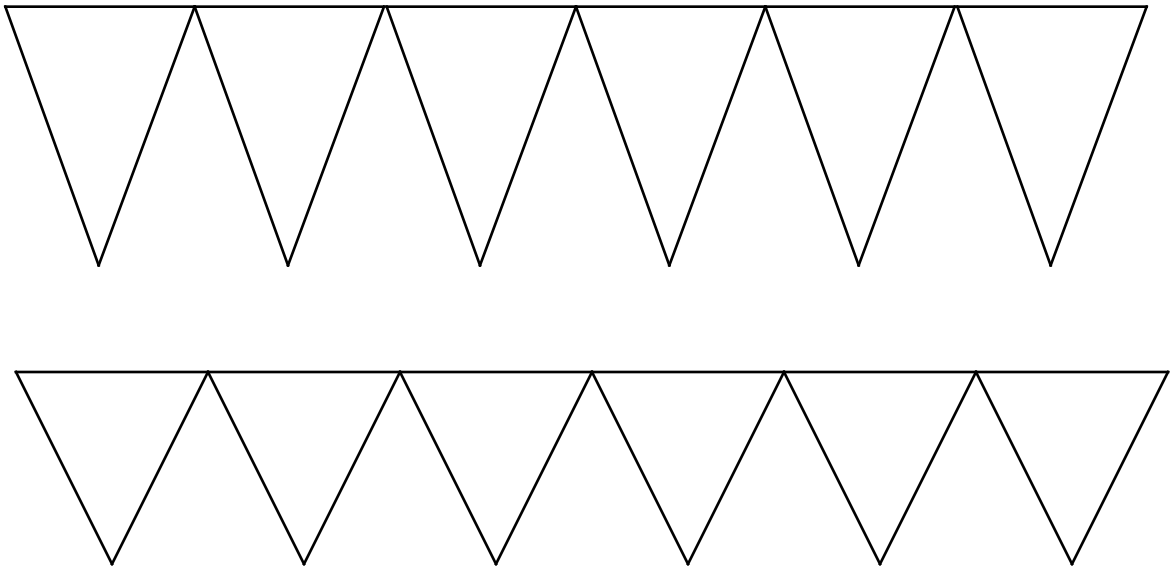
Teacher Resource #6

Banners

Directions: The Olympic Committee has appointed you to design the banner display. The triangular banners must be placed in a sequence that will not show a preference to any specific country. Therefore, the guidelines below must be followed.

1. **Banner colors are red, green, yellow, blue, black, and white.**
2. **Red and yellow may not be next to each other.**
3. **White may not be next to red.**
4. **Blue cannot be next to white.**

Design your banner below using these guidelines. Repeat the sequence twice.



What would be the color of the 14th banner? _____answers will vary_____

What would be the color of the 30th banner? _____answers will vary_____

Teacher Resource #7

Judge's Decisions

Olympic competitors in all gymnastic events receive a score from 10 judges. These scores are averaged, and the gymnast is given a score which determines their standing among the other competing gymnasts in that event. After several levels of competition, the finalists compete for a chance to earn a medal (gold, silver, or bronze) in their respective event.

Directions: Solve the problems below using your calculator.

1. Find the score that Lilia Podkopayeva would have earned if the judges gave her the scores below on her balance beam performance.

9.6, 9.8, 9.2, 9.0, 9.9, 9.4, 9.6, 9.7, 9.9, 9.5

Balance Beam average __9.6

2. Shannon Miller won the gold in this event while Lilia Podopayeva won the silver in the 1996 Olympics. You get to be the judges in this competition. Choose ten scores that would give Shannon a higher average than Lilia, so she would get the gold.

_____, _____, _____, _____, _____, _____, _____, _____, _____, _____

Shannon's average: _____ ***Answers will vary but the average of all 10 has to be greater than 9.6 (or 9.56 actually)

3. You have just finished your work on a problem in the Math Olympics and our five class judges are to hold up their score cards and rate your performance on a 0 - 10 score. You receive the following: 9.0, 8.5, 9.2, 8.9, and _____. Oops! The judge took an Almond Joy break! What must your missing score be if your average is **9.1** without rounding?

Missing Score __9.9__

How did you solve this problem? __9.1 x 5 (which is 45.5) minus the sum of the four scores (35.6), which leaves 9.9. However, answers and their respective wording will vary. Refer to the rubric to make sure that there's clear understanding and communication.

Olympic Dateline

The first modern Olympics were held in Athens, Greece in 1896. The summer Olympics have been held every four years since then.

List the dates of the first ten Summer Olympics. 1896, 1900, 1904, 1908, 1912, 1916, 1920, 1924, 1928, 1932.

List the date of the 21st Summer Olympics. 1976

How did you figure out the dates? Answers may vary; one suggested way would be to do the following: 1932 (10th) + (21 x 11 x 4); and multiple other possible ways to solve the problem.

Challenge: In 1916, 1940, and 1944, the Olympics were not held. Why do you think that they weren't held? Wars

Teacher Resource #9

Boxing For Gold

Directions: Use the table below of the 1996 Olympic Boxing gold medal winners to construct a bar graph showing the number of medals won by each of the winning countries.

Weight Class	1996 Winner
Light flyweight (48 kg)	Daniel Petrov (Bulgaria)
Flyweight (51 kg)	Maikro Romero (Cuba)
Bantamweight (54 kg)	Isan Kovacs (Hungary)
Featherweight (57 kg)	Sornluck Kamsing (Thailand)
Lightweight (60 kg)	Hocine Soltani (Algeria)
Light welterweig ht (63.5 kg)	Hector Vinent (Cuba)
Welterweight (67 kg)	Oleg Saitov (Russia)
Light Middleweight (71 kg)	David Reid (USA)
Middleweight (75 kg)	Ariel Hernandez (Cuba)
Light Heavyweig ht (81 kg)	Vasili Jirov (Kazakstan)
Heavyweight (91 kg)	Felix Savon (Cuba)
Super Heavyweight (91+kg)	Vladimir Klichko (Ukraine)

Check it Out!

Does your bar graph have a title? _____

Do you have labels for the x-axis and y-axis? _____

How many countries won gold medals in boxing? _____9____

What country won the most gold medals in boxing in the 1996 games? __Cuba_____

Name the countries that won one gold medal each. __Bulgaria, Hungary, Thailand, Algeria, Russia, U.S.A, Kazakstan, and Ukraine

Predict the country what will win the most gold medals in the next Summer Olympic competition in boxing. _____

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How far has the torch been carried after the first 22 torch-bearers? _____

Student Resource #2

Architect's Design

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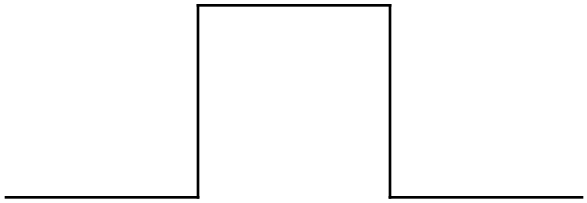

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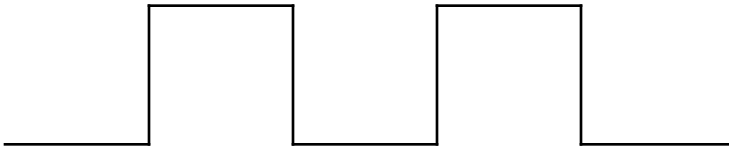

Now make three doorways using 13 toothpicks.

How many toothpicks would you need for 20 doorways? _____

How many toothpicks would you need for 50 doorways? _____

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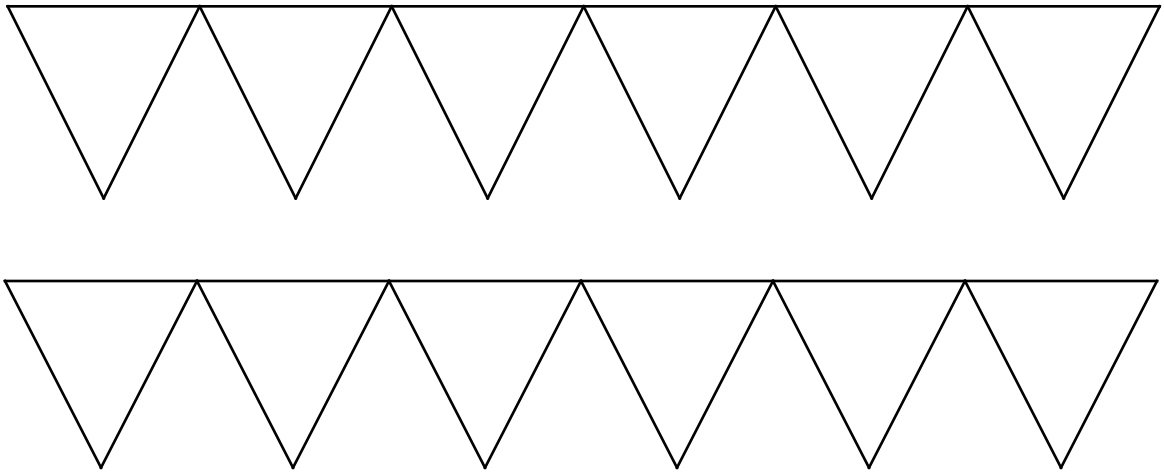

What would be the color of the 14th banner? _____

What would be the color of the 30th banner? _____

Student Resource #4

Judges' Decisions

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   Balance Beam average _____

2. Shannon Miller won the gold in this event while Lilia Podopayeva won the silver in the 1996 Olympics. You get to be the judges in this competition. Choose ten scores that would give Shannon a higher average than Lilia, so she would get the gold.

   _____, _____, _____, _____, _____, _____, _____, _____, _____, _____

   Shannon's average: _____

3. You have just finished your work on a problem in the Math Olympics and our five class judges are to hold up their score cards and rate your performance on a 0 - 10 score. You receive the following: 9.0, 8.5, 9.2, 8.9, and _____. Oops! The judge took an Almond Joy break! What must your missing score be if your average is **9.1** without rounding?

   Missing Score _____

   How did you solve this problem? _____
   _____
   _____
   _____

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_____
_____

List the date of the 21st Summer Olympics. _____

How did you figure out the dates? _____
_____
_____
_____

Challenge: In 1916, 1940, and 1944, the Olympics were not held. Why do you think that they were not held?

_____
_____

Student Resource #6

Boxing For Gold

Directions: Use the table below of the 1996 Olympic Boxing gold medal winners to construct a bar graph showing the number of medals won by each of the winning countries.

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Light Heavyweight (81 kg)	Vasili Jirov (Kazakstan)
Heavyweight (91 kg)	Felix Savon (Cuba)
Super Heavyweight (91+kg)	Vladimir Klichko (Ukraine)

Check it Out!

Does your bar graph have a title? _____

Do you have labels for the x-axis and y-axis? _____

How many countries won gold medals in boxing? _____

What country won the most gold medals in boxing in the 1996 games? _____

Name the countries that won one gold medal each. _____
_____

Predict the country that will win the most gold medals in the next Summer Olympic competition in boxing. _____

Bar Graph Grading Criteria

0	1	Graph Title
0	1	X axis is labeled correctly
0	1	Y axis is labeled correctly
0	1	Number units are on the lines
0	1	Numbers units are equally spaced
0	1	Zero is on the bottom
0	1	Handwriting is legible
0	1	Bar Graph Lines are straight
0	1	Data is accurately graphed
0	1	Overall, the graph has a neat appearance.

Total Points: _____